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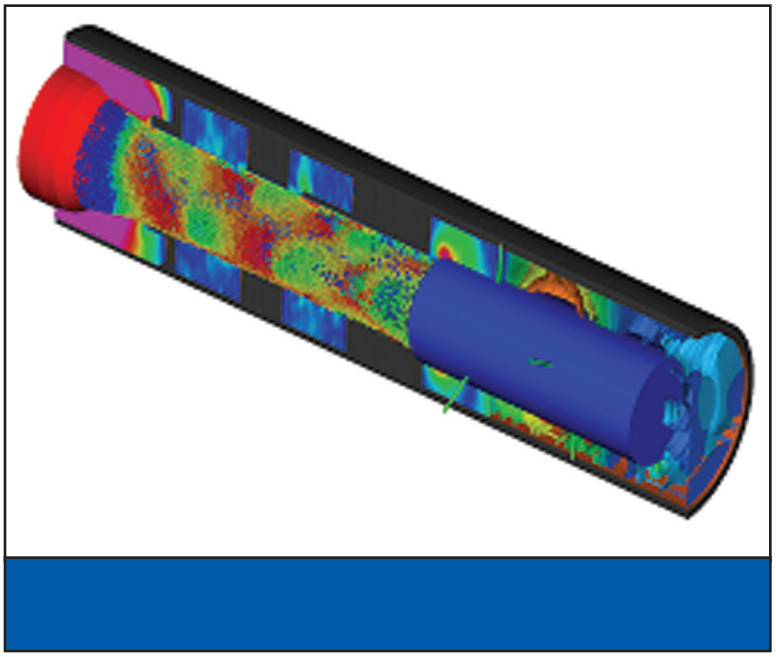
Success Story

IMPROVED CONCURRENT ELECTROMAGNETIC PARTICLE-IN-CELL MODELS



The Directed Energy Directorate is developing a particle-in-cell (PIC) code, known as Improved Concurrent Electromagnetic Particle-In-Cell (ICEPIC), that models plasmas kinetically by numerically solving Maxwell's equations coupled with the Lorentz Force Law for charged particles. ICEPIC simulates collisionless plasma physics phenomena using a Cartesian or cylindrical grid in two or three dimensions (3-D).

Directorate researchers specifically designed ICEPIC for parallel high-performance computing resources by including several novel features such as automated partitioning, dynamic load balancing, and an advanced parallel PIC algorithm. ICEPIC adds a high degree of flexibility and power to the researcher's tools for high-power microwave (HPM) source simulation.

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Accomplishment

Directorate researchers used ICEPIC to perform the first end-to-end 3-D simulation of the Magnetically Insulated Line Oscillator (MILO) with a Vlasov antenna as well as the first end-to-end 3-D simulations of the Relativistic Klystron Oscillator (RKO) (as shown in the photo). This included detailed simulations of the three separate sections: cathode, oscillator circuit, and extractor.

Researchers also used ICEPIC to discover new critical physics for long-pulse HPM radiation in the MILO and a novel inductive energy extraction method in the RKO. In addition, they used ICEPIC to perform 3-D simulations of the Gyro-Backward Wave Oscillator and Radial Acceletron.

Background

ICEPIC is written in "C" (a programming language like Pascal or Fortran) and uses the message passing interface standard to provide portability to a variety of systems. The Air Force Office of Scientific Research funds this software development effort. The directorate's High Power Microwave Division collaborates with NumerEx (a subcontractor of Science Applications International Corporation) in the development of ICEPIC. The Department of Defense High Performance Computing Modernization Office provides high-performance computing resources for the development and application of ICEPIC.

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTT, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (01-DE-12)